

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
15 March 2001 (15.03.2001)

PCT

(10) International Publication Number  
**WO 01/17700 A1**

(51) International Patent Classification<sup>7</sup>: B08B 9/032

(21) International Application Number: PCT/GB00/03394

(22) International Filing Date:  
4 September 2000 (04.09.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
9920876.1 4 September 1999 (04.09.1999) GB

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(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

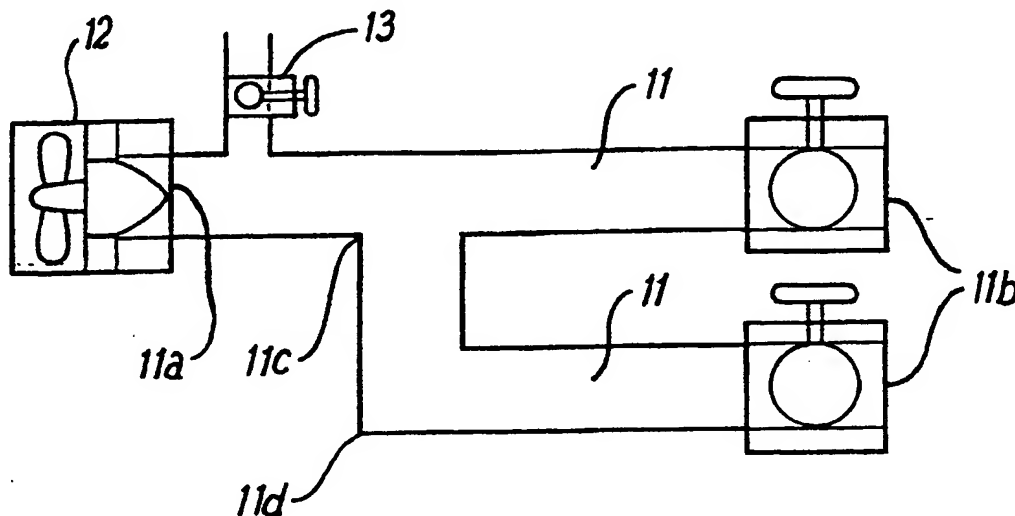
(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

— With international search report.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHODS AND APPARATUS FOR CLEARING PIPES



(57) Abstract: There is disclosed a method for clearing pipes having an inlet end (11a) and one or more outlets (11b) comprising at said inlet end (11a), forcing a gas into the pipe (11) with said outlet (11b) or at least one of said outlets (11b) open to discharge pipe contents forced through by said gas, using gas forcing means (12) capable of maintaining an overpressure sufficient therefor at a low flow velocity; when said pipe contents have been discharged, again at said inlet end (11a), and with said outlet (11b) or at least one of said outlets (11b) open, forcing a gas into the pipe (11) at a lower overpressure and a higher flow velocity to clear contents remaining in said pipe (11) after said low flow rate step.



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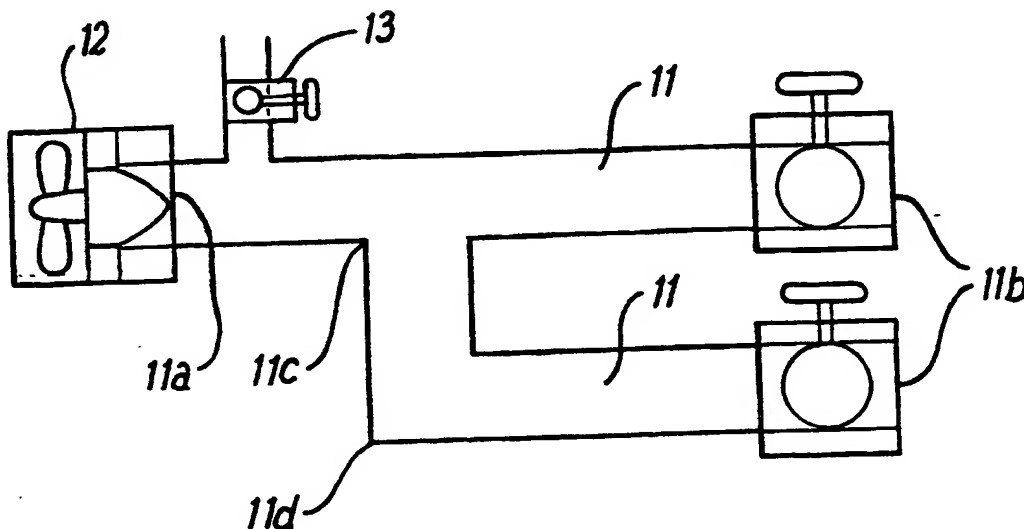


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(75) Inventor/Applicant (for US only): **ROSCOE, Keith [GB/GB]; 26 Kings Drive, Heaton Moor, Stockport, Cheshire SK4 4DZ (GB).**
- (54) Title: **METHODS AND APPARATUS FOR CLEARING PIPES**
- (81) Designated States (national): **AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MY, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.**
- (84) Designated States (regional): **ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).**
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## **METHODS AND APPARATUS FOR CLEARING PIPES**

This invention relates to methods and apparatus for clearing pipes.

Pipes, such as water pipes, pipes in industrial plants for transferring liquids, slurries, particulate materials, as well as air ducts, oil pipelines, drains and so forth, are conventionally cleared of the flowable material conveyed in them or of accumulated sediment by means of a pig, a device sent through the pipe, either by hauling or pushing or under its own power.

In straight, circular section pipes, pigs are usually quite satisfactory, but problems arise with non-circular sections or pipes which have changes in direction or bifurcations.

The present invention provides methods and apparatus for clearing pipes which represent substantial improvements over pig-associated methods and apparatus.

The invention comprises a method for clearing pipes having an inlet end and one or more outlets, comprising

- at said inlet end, forcing a gas into the pipe with said outlet or at least one of said outlets open to discharge pipe contents forced through by said gas, using gas forcing means capable of maintaining an overpressure sufficient therefor at a low flow velocity;
- when said pipe contents have been discharged, again at said inlet end, and with said outlet or at least one of said outlets open, forcing a gas into the pipe at a lower overpressure and a higher flow

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velocity to clear contents remaining in said pipe after said low flow velocity step.

The gas forcing means may serve also for the high flow velocity step.

A cleaning fluid may be introduced into the pipe after the gas forcing steps. The cleaning fluid may fill the pipe at least between the inlet end and the open outlet or outlets.

The cleaning fluid will then be discharged from the pipe - which may be done, clearly, by using the gas forcing means again, after which, with the outlet or outlets throttled down, a gas may be forced into the pipe to increase the pressure therein so that the accompanying adiabatic temperature increase dries the pipe of cleaning fluid.

The gas forced into the pipe in any or all steps may be air, indeed, will conveniently be air, though for certain applications, e.g. food and drinks manufacturing or filling plant, nitrogen or carbon dioxide may be preferred, and other gases may be used for special applications.

As a cleaning fluid, water will be the usual choice - water can easily be evaporated with an adiabatic temperature rise up to 100°C, readily attainable with a pipe overpressure of less than 1 bar. Other cleaning fluids, such as organic solvents, can be used where required, and these will often be easier to dry off than water.

The high velocity blowing step may involve a gas velocity through the pipe of the order of 20 m/s. The characteristics of a gas forcing means to achieve such a flow rate will depend upon the geometry of the pipe, and the actual velocity required may well also depend upon pipe geometry as well as on the nature of the material which is required

to be cleared. Given this “ball park” figure of 20 m/s, trial and error will readily establish the gas forcing requirements for any given pipe system.

Likewise, the amount of overpressure required for an adiabatic heating drying step can be readily calculated from Boyle’s Law, and the gas forcing requirements adjusted to achieve that, if not already adequate from pipe clearing considerations, while the throttling can be adjusted to bring about the required pressure increase while ensuring a sufficient flow through of the gas to eliminate the evaporated cleaning fluid.

The invention also comprises apparatus for clearing pipes, comprising

- gas forcing means connecting to an inlet end of the pipe;
- valve means adapted to throttle down an outlet of the pipe;
- said gas forcing means and valve means being adapted to the pipe to cooperate to effect both higher pressure, low flow velocity and lower pressure, high flow velocity of gas through the pipe.

The gas forcing means may comprise a pump.

The gas forcing means may however comprise blower, turbine or compressor means, which may be capable of generating a gas flow velocity through the pipe of the order of 20 m/s.

The forcing means and valve means may be adapted to the pipe to cooperate to elevate the pressure inside the pipe so as to increase the temperature of the gas in the

pipe to evaporate a cleaning liquid while maintaining a flow out of the pipe through said valve means.

The apparatus may be built into a manufacturing plant, either as a retrofit into an existing plant, or as a custom installation in new plant. Portable apparatus may be used, however, for example to provide a service whether for routine or occasional pipe clearing. Access for the gas forcing means and connections for the outlet valving may be designed into new plant or may be retrofitted and left after use for future use, or may be improvised as required.

The apparatus may comprise a control arrangement controlling the gas forcing means. The control arrangement may control the gas forcing means in accordance with conditions in the pipe, and may comprise a relief valve and/or a pipe internal pressure measuring device and/or a pipe internal temperature measuring device.

The control means may control the output of the gas forcing means. The gas forcing means may comprise a rotary blower and the control means may control the rate of rotation thereof. If the blower is electrically powered, speed control may be *via* a frequency converter.

The control arrangement may comprise a programmed computer, which may be programmed to cause the gas forcing means and all ancillary equipment to operate in accordance with sensed variables and/or to a time regime.

A major application for the method is in the area of drains from domestic, commercial and industrial premises, which are currently unblocked using rodding or water jet technologies - pigs are not usually feasible. With drainage systems that may be anything but straight, even broken, with adjacent parts misaligned and possibly of

differing cross-section along their length, rodding and jetting systems can be problematical at best, and potentially capable of damaging a pipe, or adding to damage already present.

Apparatus according to the invention can be trailer-mounted for servicing drains - of course, building drains will not usually require anything beyond the clearing steps, and so fitting a throttled outlet will not usually be required.

Embodiments of apparatus and methods for clearing pipes according to the invention will now be described with reference to the accompanying drawings, in which:-

- Figure 1 is a diagrammatic illustration of a basic system according to the invention;
- Figure 2 is a diagrammatic illustration of an installation in a typical manufacturing plant;
- Figure 3 is an elevation of a typical blower end of an apparatus;
- Figure 4 is an elevation of an outlet end for the apparatus of Figure 3 arranged for pipe clearing; and
- Figure 5 is an elevation of the outlet end of Figure 4, arranged for liquid cleaning and drying.
- Figure 6 is a diagrammatic view of a drain clearing arrangement; and

Figure 7 is a layout of a trailer for drain clearing.

The drawings illustrate methods and apparatus for clearing pipe 11 having an inlet end 11a and one or more outlet ends 11b. In the diagrammatic apparatus of Figure 1, there are two outlet ends 11b, there being a branch 11c in the pipe 11. It is just such a branch, as well as bend 11d in the pipe 11, that gives rise to problems in rodding and jetting.

The method, as illustrated in Figure 1, comprises

- at said inlet end 11a, forcing a gas into the pipe 11 with said outlet end 11b, or at least one of said outlet ends 11b open to discharge pipe contents blown through by said gas - having only one outlet 11b open at a time reduces the requisite blower capacity clearly - using blower means 12 capable of maintaining an overpressure sufficient to blow through the pipe contents at a low flow rate;
- when said pipe contents have been discharged, again at said inlet end 11a and with said outlet end or at least one of said outlet ends open, blowing a gas into the pipe 11 at a low overpressure and a high flow rate to clear contents remaining in said pipe 11 after said low flow rate step.

A throttling or relief valve 13 will usually be provided. This will be throttled down or set to open at a given internal pressure in the pipe 11 to protect the same.



Whilst it would be possible to use different pump or blower means for the two steps, using a single blower capable of operating in both pressure/flow rate modes will save on capital cost of equipment and the time and trouble of changing over.

The method is of general applicability, regardless of the length of the pipe - pipelines up to several kilometres in length could be cleared in this way - and regardless, also, of the cross-sectional size or shape of the pipe. Thus the method may be used to clear process pipework in industrial plants, hot air and air conditioning ducting, drains and sewers, even if the pipe is damaged or changes in cross-section (whether shape or size) or direction (even if there are right-angle bends), and even if there are sharp steps in the pipe and internal obstructions such as instrument probes, flanges, or tree roots in drains and sewers.

The high pressure, low velocity step will usually clear away the bulk of material in the pipe, leaving, however, material that may lie in U-formations or be trapped against protuberances - it will, at least, clear a gas flow path through the pipe.

The low pressure, high velocity step will clear out any such detritus left behind after the high pressure step. The lifting power of a fluid flow can be proportional to the fourth power of its velocity - even a small increase in velocity above a nominal 20 m/s can result in a substantially greater ability to pick up and carry out liquids, solids or mixtures thereof left in the pipe after the high pressure, low velocity step.

The cleaning fluid - which will usually be water, but which may be any other liquid appropriate to the cleaning task in hand, for example an organic solvent - may flow through the pipe and be cleared from the pipe if necessary by re-use of the high pressure, low velocity and low pressure, high velocity gas blowing steps.

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Any film of cleaning fluid left on the walls of the pipe and, of course, any pools of fluid left behind by the blowing operations, will be evaporated by adiabatic heating as the pipe outlet is throttled down, leading to a pressure increase while permitting flow through the pipe to carry away the evaporated cleaning fluid.

Figure 2 illustrates the method and apparatus of the invention in the context of an industrial plant in which a product, for example, minestrone soup for canning, is mixed in a mixing tank 21 for transfer by pipe 22 to a stock tank 23 whence by pipe 24 to a filler arrangement 25 for the cans or other containers for shipment, retail and so on.

Transfer from mixing tank 21 to stock tank 23 is effected by a pump 25, and from stock tank 23 to filler arrangement 25 by a pipe 26. A valve 27 allows the product filling operation or product transfer to other receptacles.

The additional equipment according to this embodiment of the invention comprises a blower unit 29 and valves 29a, 29b, 29c, 29d, 29e, 29f, 29g.

The blower unit 29, which is essentially a ducted fan arrangement, is connected to valves 29a and 29b by a gas delivery pipe 31, thence to valve 29e by a gas delivery pipe 32. Valves 29c and 29f deliver process water or cleaning fluid.

To clear the pipe 22, the blower unit 29 is turned on with valves 29a and 29b connecting it to the pipe 22. The high pressure, low velocity initial flow from the blower unit 29 pushes product out of the pipe 22 into the receiving stock tank 23, and the ensuing low pressure/high velocity flow then cleans out any product not cleared by the high pressure, low volume flow.

Cleaning liquid, e.g. water, can then be introduced *via* valve 29c, the valve 29a being shut off from the blower unit 29 but open to the pipe 22. The cleaning liquid can be pumped into and through the pipe 22 by a separate pressure source. When this operation is completed, the valve 29c is shut off from the cleaning fluid supply, and valves 29a and 29b opened to connect the pipe 22 to the blower unit 29. When the cleaning liquid has been expelled to waste, valve 29d is throttled down so that the gas pressure inside pipe 22 increases to heat the gas adiabatically and evaporate the cleaning liquid, which is expelled from the valve 29d as vapour carried in the gas outflow.

The process is repeated for pipe 26.

An important advantage over prior art methods of process pipe cleaning is that product is not lost to waste, but can be delivered to a stock tank - no foreign body is inserted into the pipe that might spoil or contaminate the pipe contents.

Figure 2 shows cleaning liquid connectible *via* valves 29c and 29f to pipes 22 and 26 in turn.

The entire arrangement can be made as a retrofit to existing plant, or designed into new plant.

Figures 3, 4 and 5 are elevations showing how one arrangement would appear in practice.

Figure 3 illustrates the blower unit 29, which comprises a motor 41, driving a fan 42. A valve tree 43 includes a filter 44 so that the blower unit 29 delivers filtered air to the pipe 22. Valve 29a is shown, without connection from the mixing tank 21, connecting to the pipe 22, Figure 2.

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Figure 4 shows a possible arrangement at the outlet end, or an outlet end of a system such as is illustrated in Figure 2, in which the pipe 22 terminates in a riser 22a with an attached section 22b delivering into a receiving tank 51. Figure 5 shows the same riser 22a to the pipe 22 adapted for the adiabatic temperature increase by the section 22b being removed and substituted by a valve arrangement 52 which can be opened for passage of a cleaning fluid before being throttled down for the adiabatic heat generation. Valve units 52 can be located at different positions in a pipe system so that different sections of pipe can be treated individually.

As mentioned, the method is adaptable to many different pipe clearing operations covering all lengths and cross-sections (size, shape) of pipe, conveying all manner of products, such as liquids, slurries, powders. The apparatus may, according to the invention, be built in to commercial premises or industrial plant, or may be mounted on a trailer for deployment on an ad hoc basis, for example as an alternative or an auxiliary to conventional drain rodding and jetting equipment.

Various adaptations of the method are envisaged. In one adaptation, the method is used, not as a method of cleaning pipes for maintenance purposes, rather as an integral part of a manufacturing process - a pipe can have a definitive volume and that volume of product can be precisely delivered by filling the pipe and then clearing its contents into a receiving tank.

The method, in broad aspect, can also be employed in connection with drains and sewers on a routine basis. The second - high velocity, low pressure - part of the process would be particularly beneficial in controlling flow through and levels in drains and sewers, keeping them generally free from accumulation of debris. Blowers and valves can be fitted at strategic locations to control flow in sections of sewer.

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By “gas forcing means” is to be understood any appropriate apparatus for forcing gas or air through the pipe in question. An internal combustion engine-powered blower may be suitable for portable apparatus (such as equipment for cleaning sewers and drains). Where heat greater than that which can be produced by adiabatic heating at pressures the pipe can stand or can attain (eg. due to leaks in sewers) for example for pasteurisation, is required, a heating blower can be used or - and especially where large pipes or systems are concerned, even a gas turbine.

Figures 6 and 7 shown a drain clearing arrangement according to the invention.

A mobile unit, on trailer 61, which houses (Figure 7) a blower 71 driven by an appropriately geared prime mover 72, shown as a petrol engine with a fuel tank 73, and an outlet pipe 74 with a valved pipe connector 75, is towable to an access point 62, for a drain or sewer 63 where the exposed end 63a of the drain or sewer 63 is fitted with a bung 64 accepting a fitting 65 rammed against the end 63a by an adjuster 66.

The fitting 65 is connectible to a flexible hose 67 from the unit 61, and has a valved inlet 67 for a supply of water - other valved openings may also be fitted, e.g. for a water spray.

At a downstream access point 68, the end 63b of the drain or sewer 63 is fitted with a connector 69 held in by another adjuster 66. For clearing, the collector can be exchanged for a valve arrangement to control flow of cleaning fluid and air for adiabatic heating, if desired, though this will not always be a requirement in drain and sewer clearing.

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The prime mover 72 has a central panel 76 and there is a separate control panel 77 for setting up and controlling the blowing arrangements, valving and so forth.

**CLAIMS**

1. A method for clearing pipes having an inlet end and one or more outlets comprising
  - at said inlet end, forcing a gas into the pipe with said outlet or at least one of said outlets open to discharge pipe contents forced through by said gas, using gas forcing means capable of maintaining an overpressure sufficient therefor at a low flow velocity;
  - when said pipe contents have been discharged, again at said inlet end, and with said outlet or at least one of said outlets open, forcing a gas into the pipe at a lower overpressure and a higher flow velocity to clear contents remaining in said pipe after said low flow rate step.
2. A method according to claim 1, in which the said forcing means serve also for the higher flow velocity step.
3. A method according to claim 1 or claim 2, in which a cleaning fluid is introduced into the pipe after the gas forcing steps.
4. A method according to claim 3, in which the cleaning fluid fills the pipe at least between the inlet end and the open outlets or outlets.
5. A method according to claim 3 or claim 4, in which the cleaning fluid is discharged from the pipe and, with the outlet or outlets throttled down, a gas is forced

into the pipe to increase the pressure therein so that the accompanying adiabatic temperature increase dries the pipe of cleaning fluid.

6. A method according to any one of claims 1 to 5, in which the gas forced into the pipe is air.

7. A method according to any one of claims 3 to 6, in which the gas is forced into the pipe by the same forcing means for each step.

8. A method according to any one of claims 1 to 7, in which the higher flow velocity step involves a gas velocity through the pipe of the order of 20 m/s.

9. Apparatus for clearing pipes, comprising

- gas forcing means connecting to an inlet end of the pipe;
- valve means adapted to throttle down an outlet of the pipe;
- said gas forcing means and valve means being adapted to the pipe to cooperate to effect both higher pressure, low flow velocity and lower pressure, higher flow velocity of gas through the pipe.

10. Apparatus according to claim 9, in which the forcing means comprise a pump.

11. Apparatus according to claim 9, in which the forcing means comprise blower means.

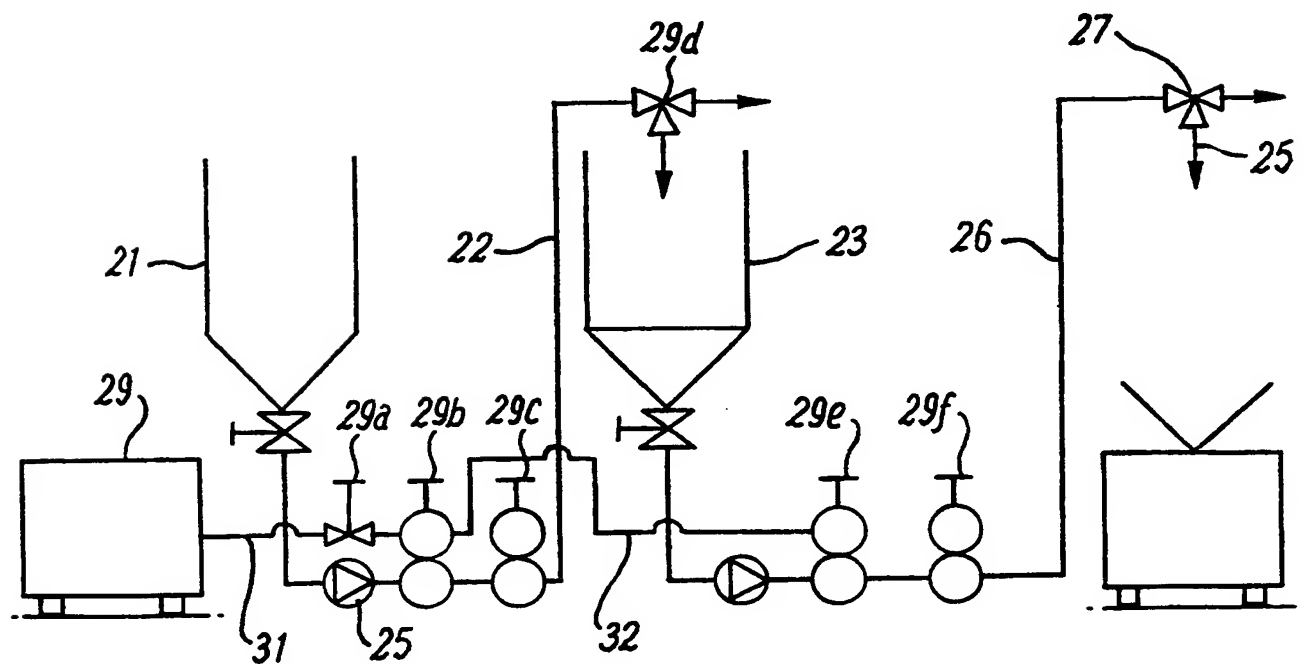
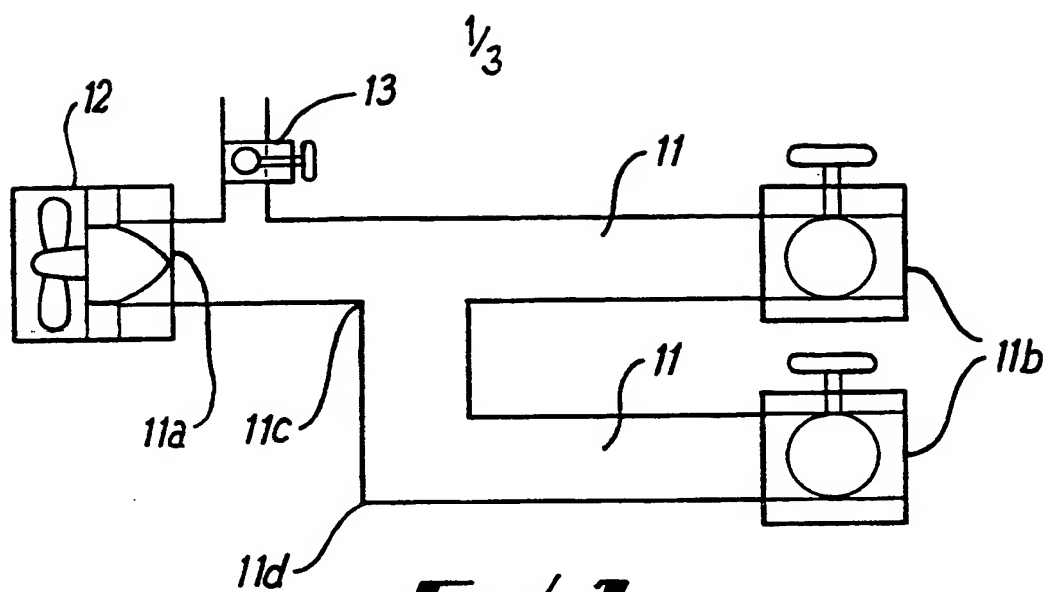


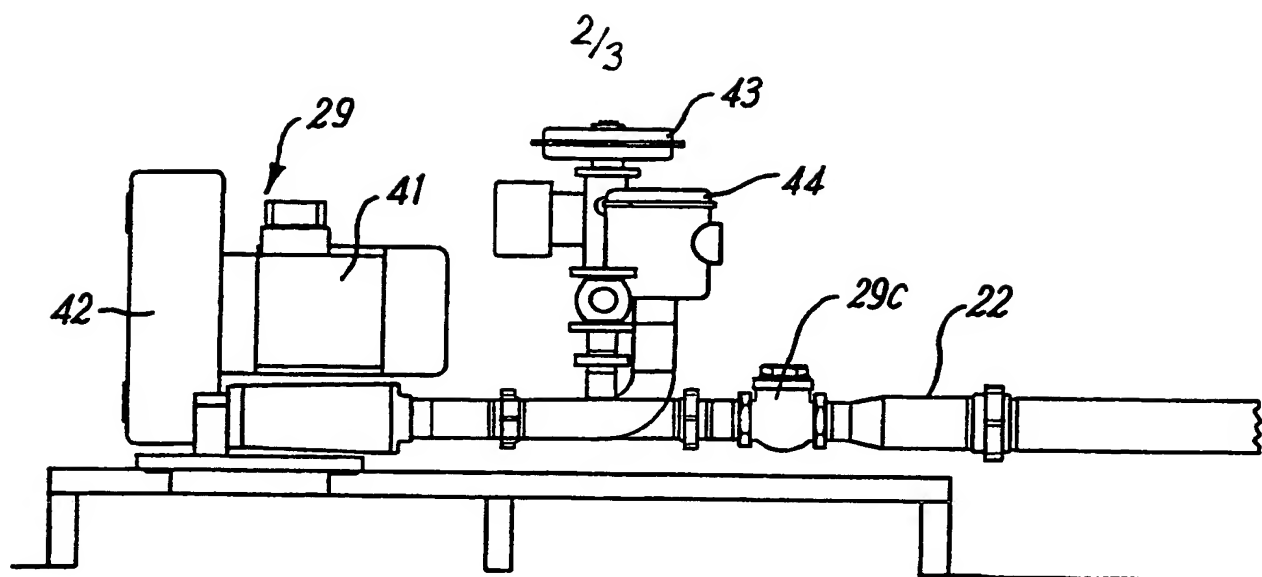
- 15 -

12. Apparatus according to claim 11, in which the blower means are capable of generating a gas flow velocity through the pipe of the order of 20 m/s.
13. Apparatus according to any one of claims 7 to 11, in which the forcing means and valve means are adapted to the pipe to cooperate to elevate the pressure inside the pipe so as to increase the temperature of the gas in the pipe to evaporate a cleaning liquid while maintaining a flow out of the pipe through said valve means.
14. Apparatus according to any one of claims 9 to 13, comprising a control arrangement controlling the gas forcing means.
15. Apparatus according to claim 14, in which the control arrangement controls the gas forcing means in accordance with conditions in the pipe.
16. Apparatus according to claim 15, in which the control arrangement comprises a pressure relief valve.
17. Apparatus according to any one of claims 14 to 16, comprising a pipe internal pressure means device
18. Apparatus according to any one of claims 14 to 17, comprising a pipe internal temperature measuring device.
19. Apparatus according to any one of claims 14 to 18, in which the control means control the output of the gas forcing means.
20. Apparatus according to claim 19, in which the gas forcing means comprise a rotary blower and the control means control the rate of rotation thereof.

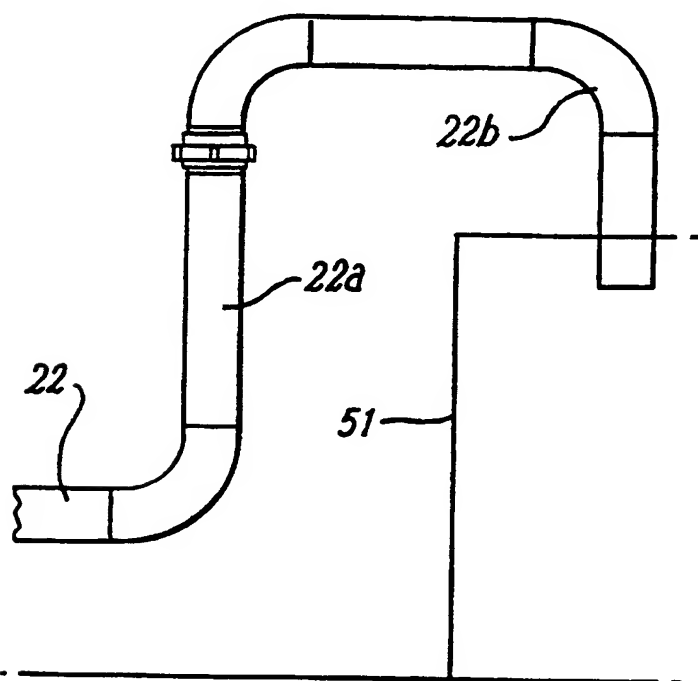
- 16 -

21. Apparatus according to claim 20, in which the blower is electrically powered and speed control is *via* a frequency converter.
22. Apparatus according to any one of claims 14 to 21, in which the control arrangement comprises a programmed computer.
23. Apparatus according to claim 22, in which the computer is programmed to cause the gas forcing means and all ancillary equipment to operate in accordance with sensed variables and/or to a time regime.

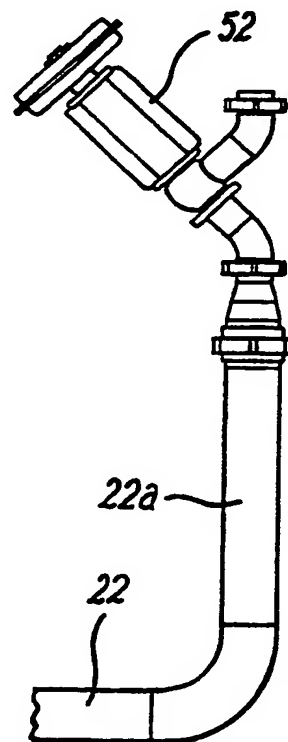




***Fig. 3***

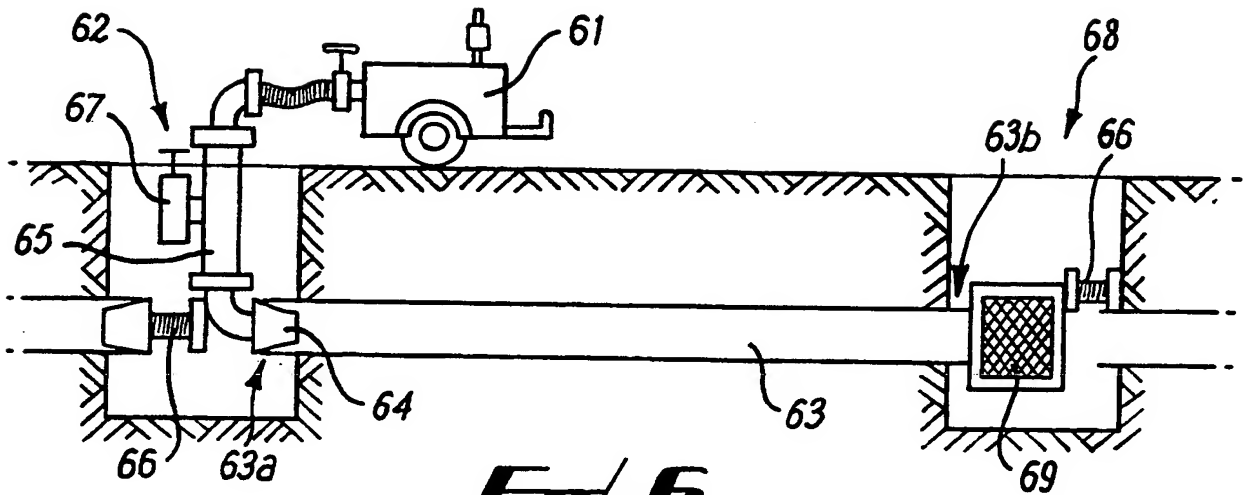


***Fig. 4***

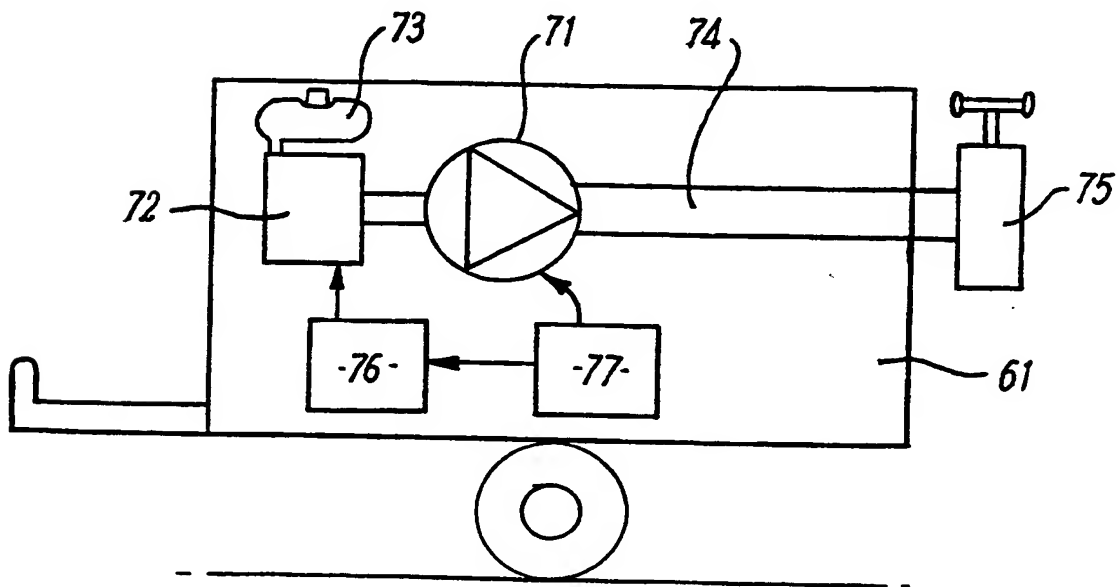


***Fig. 5***

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**FIG. 6**



**FIG. 7**

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/03394

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 B08B9/032

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B08B E03F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 26 29 301 A (ENNEKING) 5 January 1978 (1978-01-05) page 5, line 26 - line 30 page 9, line 24 -page 10, line 5; figure	1,2,6,7, 9-11,14
Y		3,15,17, 19-23
Y	US 5 915 395 A (SMITH) 29 June 1999 (1999-06-29) abstract column 2, line 4 - line 37 column 3, line 6 - line 49 column 4, line 23 -column 5, line 4; figures	3
A		1,6, 9-11,14

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

7 December 2000

Date of mailing of the international search report

15/12/2000

Name and mailing address of the ISA  
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Van der Zee, W

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/03394

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 724 701 A (JONES) 10 March 1998 (1998-03-10) abstract column 4, line 60 -column 5, line 5 column 6, line 23 - line 31 column 7, line 41 - line 52 column 8, line 14 - line 21; figures 1,3	15,17, 19-23
A	-----	1,6, 9-11,14, 18

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 00/03394

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